

CLAIMS

1. A method for adjusting an output parameter of a circuit, the method comprising:

(a) providing in said circuit a plurality of components including at least one thermally trimmable resistor and at least one other component, and positioning said at least one thermally trimmable resistor in said circuit such that said output parameter is affected by variations of parameters of said at least one thermally trimmable resistor;

(b) trimming a resistance value and a temperature coefficient of resistance of said at least one thermally trimmable resistor to independent values to cause a change in said output parameter; and

(c) measuring said output parameter.

2. A method as claimed in claim 1, further comprising repeating steps (b) and (c) until said output parameter has been adjusted as desired.

3. A method as claimed in claims 1 or 2, wherein said trimming comprises applying a heating cycle, and said heating cycle comprises a sequence of heat pulses to trim said resistance value in a first direction and a sequence of heat pulses to trim said resistance value in an opposite direction.

4. A method as claimed in claim 3, wherein said heating cycle trims said resistance value away from and then back to its initial value.

5. A method as claimed in any one of claims 3 or 4, wherein said trimming comprises selecting parameters of said heating cycle to determine a direction of trimming and an amount of trimming of said temperature coefficient.

6. A method as claimed in claim 5, wherein said selecting parameters comprises selecting a first heat pulse of said sequence of heat pulses of said heating cycle to be of a given amplitude to determine a change in said temperature coefficient.

7. A method as claimed in claim 6, wherein said trimming comprises driving said temperature coefficient down by using a high amplitude first pulse above a

temperature coefficient change reversal threshold, and driving said temperature coefficient up using lower first pulses below said threshold.

5 8. A method as claimed in any one of claims 3 to 7, wherein said trimming comprises applying a plurality of heating cycles.

9. A method as claimed in any one of claims 3 to 8, wherein said parameter can be measured at room temperature, and said temperature coefficient of resistance can be measured without changing an ambient temperature of said
10 circuit before applying a succeeding heat pulse.

10. A method as claimed in claim 9, wherein said temperature coefficient is measured during a cooling of said component with respect to an arbitrary scale.

15 11. A method as claimed in claim 6, wherein said trimming comprises providing a heating cycle having a first pulse just above a trimming temperature threshold to obtain a slow rate of change of said parameter, and a negligible change in said temperature coefficient.

20 12. A method as claimed in any one of claims 1 to 11, wherein said providing in said circuit comprises providing at least one active semiconductor device.

13. A method as claimed in any one of claims 1 to 12, wherein said trimming comprises trimming to cause a change to a non-linear temperature variation of
25 an output of said circuit.

14. A method as claimed in any one of claims 1 to 13, wherein said trimming comprises trimming to cause a change to an output voltage of said circuit.

30 15. A method as claimed in any one of claims 1 to 14, wherein said providing in a circuit comprises providing a voltage reference circuit having at least one trimmable resistor.

16. A method as claimed in claim 15, wherein said at least one trimmable resistor comprises a pair of trimmable resistors, and said trimming comprises trimming said pair of trimmable resistors.

5 17. A method as claimed in claim 16, wherein said trimming comprises using said pair of trimmable resistors as a voltage divider to trim.

18. A method as claimed in any one of claims 16 and 17, wherein said trimming comprises trimming said pair of trimmable resistors to predetermined resistance
10 values.

19. A method as claimed in any one of claims 16 to 17, wherein said trimming comprises trimming said pair of trimmable resistors to a predetermined ratio of resistance values.

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20. A method as claimed in any one of claims 16 to 19, wherein said trimming comprises trimming said pair of trimmable resistors to matched temperature coefficients of resistance values.

20 21. A method as claimed in any one of claims 16 to 19, wherein said trimming comprises trimming said pair of trimmable resistor to a predetermined temperature coefficient of resistance difference.

22. A method as claimed in claim 15, wherein said providing a voltage reference
25 circuit comprises providing at least one external resistor, external to a chip including said circuit.

23. A method as claimed in claim 22, wherein said at least one trimmable resistor comprises said at least one external resistor, and said trimming
30 comprises trimming said external resistor.

24. A method as claimed in claim 22, wherein said providing at least one external resistor comprises providing a pair of external resistors, said at least

one trimmable resistor comprises said pair of external resistors, and said trimming comprises trimming said pair of external resistors.

25. A method as claimed in any one of claims 1 to 24, wherein said providing in
5 said circuit comprises providing a thermally trimmable resistor having a range of temperature coefficient values available for trimming such that it can compensate for other components in said circuit.

26. An apparatus for adjusting an output parameter of a circuit, the apparatus
10 comprising:

a circuit having a plurality of components including at least one thermally trimmable resistor and at least one other component, said at least one thermally trimmable resistor positioned in said circuit such that said output parameter is affected by variations of parameters of said at least one thermally trimmable
15 resistor;

heating circuitry having a decision-making module for applying heating cycles, each heating cycle comprising a sequence of heat pulses to trim a resistance value of said thermally trimmable resistor in a first direction and a sequence of heat pulses to trim said resistance value of said thermally trimmable resistor in an opposite direction, and wherein each heating cycle trims
20 a temperature coefficient of resistance of said thermally trimmable resistor by an increment and thereby affects said output parameter of said circuit; and

measuring circuitry for measuring said output parameter of said circuit.

25 27. An apparatus as claimed in claim 26, wherein said decision-making module is for determining an amplitude of a heat pulse, a duration of said heat pulse, and a time interval before a succeeding heat pulse.

28. An apparatus as claimed in any one of claims 26 to 27, wherein said heating
30 circuitry comprises a heating element for heating said electrical component.

29. An apparatus as claimed in any one of claims 26 to 28, wherein said decision-making module determines said amplitude of a heat pulse, duration of said heat pulse, and time interval before a succeeding heat pulse as a function

of a history of pulses applied to said electrical component.

5 30. An apparatus as claimed in any one of claims 26 to 29, wherein said measuring circuitry and said calculating circuitry are on a same chip as said circuit.

31. An apparatus as claimed in any one of claims 26 to 30, wherein said circuit comprises at least one active semiconductor device.

10 32. An apparatus as claimed in any one of claims 26 to 31, wherein said circuit comprises a voltage reference circuit having said at least one thermally trimmable resistor.

15 33. An apparatus as claimed in claim 32, wherein said at least one thermally trimmable resistor comprises a pair of thermally trimmable resistors.

34. An apparatus as claimed in claim 33, wherein said pair of resistors is a voltage divider.

20 35. An apparatus as claimed in any one of claims 33 to 34, wherein said heating circuitry is adapted to trim said pair of thermally trimmable resistors to predetermined resistance values.

25 36. An apparatus as claimed in any one of claims 33 to 34, wherein said heating circuitry is adapted to trim said pair of thermally trimmable resistors to a predetermined ratio of resistance values.

30 37. An apparatus as claimed in any one of claims 33 to 36, wherein said heating circuitry is adapted to trim said pair of thermally trimmable resistors to matched temperature coefficients of resistance values.

38. An apparatus as claimed in any one of claims 33 to 36, wherein said heating circuitry is adapted to trim said pair of thermally trimmable resistor to a predetermined temperature coefficient of resistance difference.

39. An apparatus as claimed in any one of claims 32 to 33, wherein said voltage reference circuit comprises at least one external resistor, external to a chip including said circuit.

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40. An apparatus as claimed in claim 39, wherein said at least one thermally trimmable resistor comprises said at least one external resistor.

41. An apparatus as claimed in claim 39, wherein said at least one external resistor comprises a pair of external resistors, and said at least one thermally trimmable resistor comprises said pair of external resistors.

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42. An apparatus as claimed in any one of claims 26 to 41, wherein said output parameter comprises a non-linear temperature variation to said output of said circuit.

43. An apparatus as claimed in any one of claims 26 to 42, wherein said output parameter comprises an output voltage of said circuit.

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44. A method as claimed in any one of claims 26 to 43, wherein said at least one thermally trimmable resistor has a range of temperature coefficient values available for trimming such that it can compensate for said other components in said circuit.

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45. An apparatus as claimed in any one of claims 26 to 44, wherein said measuring circuitry is also adapted to measure said resistance and said temperature coefficient of resistance of said at least one thermally trimmable resistor.

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46. An apparatus as claimed in any one of claims 26 to 44, wherein said circuit comprises at least one micro-platform suspended above a cavity, and said at least one thermally trimmable resistor is on said micro-platform.

47. An apparatus as claimed in claim 46, wherein said at least one thermally trimmable resistor is a pair of thermally trimmable resistors, and said pair is on said micro-platform.

5 48. An apparatus as claimed in claim 47, wherein said circuit comprises a symmetrically positioned heater between said pair of thermally trimmable resistors on said micro-platform.

10 49. An apparatus as claimed in claim 46, wherein said circuit comprises a heat source having a power dissipation geometry adapted to obtain a substantially constant temperature distribution across said at least one thermally trimmable resistor when a temperature of said thermally trimmable resistor is raised for trimming purposes.